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ON A METHOD OF MEASUREMENT OF THE NORTH-SOUTH COMPONENT OF ULTRASHORT WAVE REFRACTION IN THE IONOSPHERE AND OF OTICAL THICKNESS GRADIENT

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SUMMARY

The method consists essentially in the use, instead of horizontal radiointeferometers, of a "polar" interferometer, whose base is parallel to the axis of the celestial sphere, thus allowing the measurement of the North-South component of a sporadic refraction at small zenithal angles, and consequently the gradients of electron concentration in the same direction.

* * *

Radioastronomical methods of investigation of ionosphere irregularities with the help of horizon radiointerferometers are beset with some shortcomings; the indeed allow only measurements of sporadic radiowave refraction components, and consequently the gradients of electron concentration in the ionosphere, in directions near East-West. This is especially referred to the region of small zenithal angles (to $\sim 40^{\circ}$).

Measurement of the North-South component of irregular refraction at small zenithal angles can be achieved with the help of a "polar" interfermometer, that is, of an inteferometer, the base of which is parallel to the axis of the celestial sphere. For such an instrument the angle between the direction at radioemission source and the normal to the base is constant and is equal to the declination δ of the source. Thus, the source appears as moving "along" the interferogram.

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* OB ODNOM METODE IZMERENIYA SEVERNO-YUZHNOY SOSTAVLYAYUSHCHEY REFRAKTSII UKB V IONOSFERE I GRADIENTA OPTICHESKOY TOLSHCHI.

We shall compute the angular response of a polar interferometer. Limiting ourselves to considering only the irregular refraction ΔR, we may write for the angle of incidence of a ray from the source φ:

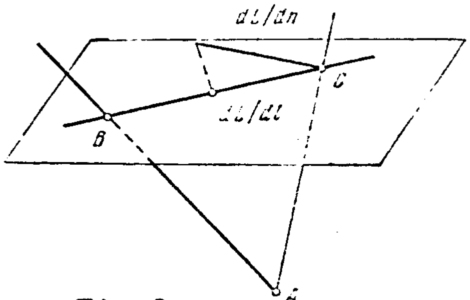

Fig. 1

$$\varphi = \delta + \Delta R. \quad (1)$$

The output device of the interferometer registers the received radiation in temperature units :

$$T = T_0 F(\varphi) \cos\left(\frac{2\pi D}{\lambda}\sin\varphi\right), \quad (2)$$

where T_0 is the antenna temperature from the given source; $F(\varphi)$ - is the normalized antenna radiation pattern; D is the interferometer base length ; λ is the wavelength.

When measuring the angle of ray incidence upon ΔR, the device registers the accretion of temperature :

$$\Delta T = T_0 \Delta F(\varphi) \cos\left(\frac{2\pi D}{\lambda}\sin\varphi\right) - T_0 F(\varphi) \sin\left(\frac{2\pi D}{\lambda}\sin\varphi\right)\frac{2\pi D}{\lambda}\cos\varphi\Delta R. \quad (3)$$

The first term of the expression (3) at not too great φ is by $D_{base}/D_{antenna}$ times smaller than the second one and can therefore be neglected. It is easy to select

$$\sin\left(\frac{2\pi D}{\lambda}\sin\varphi\right) = 1, \quad (4)$$

by electric shift of the interferogram, and we shall finally have

$$|\Delta T| = T_0 F(\varphi)\frac{2\pi D}{\lambda}\cos\varphi\,|\Delta R|, \quad (5)$$

whence the minimum detectable value of refraction oscillations is

$$|\Delta R| = |\Delta T|\lambda / 2\pi D T_0 \cos\varphi F(\varphi), \quad (6)$$

where ΔT is the sensitivity of the interferometer's receiver. Numerical estimates show that the angular response of a polar interferometer is better than that of a horizontal for the same values of $|\Delta T|$, T_0 and D.

The determination of the magnitude and direction of the component of optical thickness gradient $\overline{dL}/dl$ along the layer by the measured value of irregular refraction $\Delta R = \overline{dL}/dn$ (n being the normal to the ray) and the known coordinates of the source and interferometer base orientation is, in general case, a complex geometrical problem. However, at small zenithal angles its solution is significantly simplified by the possibility of substitution of the spherical ionospheric layer, responsi le for the oscillation of refraction, by a plane one. The relative error in the determination of $\overline{dL}/dl$, induced by this simpiification, should not exceed 6% for zenithal angles to $\sim 40^{\circ}$ and ionosphere layer heights to 500 km. Because of interferogram's axial symmetry, the direction $\overline{dL}/dl$ is given by a stright line BC, defined by the point of encounter of interferometer base AB and the direction at the source AC with the ionosphere plane (see Fig. 1); A is the point of observation.

Note in conclusion, that contrary to the method of measurement of ionosphere refraction with the help of interferometers with horixontal bases, the proposed method has the unquestionable merit, that it allows to measure the sporadic refraction uninterruptedly during the observation session.

*** THE END ***

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NO REFERENCES

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